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## CRYSTALLOGRAPHY BY A PHYSICIST.

*Cours de Physique.* By Prof. H. Bouasse. Sixième partie, Etude des Symétries. Pp. 424. (Paris: Ch. Delagrave, n.d.) Price, 14 francs.

THIS sixth volume of the course of physics, prepared by the author to conform "aux programmes des Certificats et de l'Aggrégation de Physique," deals with the subject of symmetry, both from the general physical standpoint and as it concerns crystals. The previous volumes have treated of mechanical physics, thermodynamics, electricity and magnetism, optics, and electro-optics. Besides actual symmetry, this sixth volume also discusses symmetrical deformation, double refraction in relation to the symmetry of crystals, the bearing of optical rotation on crystal symmetry, and a concluding brief account of liquid crystals. It presents many of the phenomena dealt with by the expert crystallographer from the very different outlook of the pure physicist, and such an outside view, by a competent authority, of a more or less special branch of science is usually of value, although one must not look either for specialised knowledge or intimate acquaintance with the phenomena described. In these days of specialists there are very few men able to deal without error with so many subjects as are included in the comprehensive course of Prof. Bouasse.

The reader is very much handicapped at the outset by the lack of any index, either of authors or subjects, but it is impossible not to be struck with the fact that the references to original investigations are almost entirely confined to those of French men of science. With the exception of a brief inevitable reference to Miller, whose notation was bound to be mentioned, we look in vain for any recognition of the many important contributions to our knowledge of both general and crystallographic symmetry which have been made during the last twenty years by British investigators, such as Maskelyne, Miers, Barlow, and Hilton, or of the large additions to chemical crystallography effected in this country. The work of Sohncke and Schönflies is referred to, and a passing mention of von Fedorow made, but anything approaching appreciation of the later most important work of the latter investigator and of Barlow is not forthcoming. Nor could any reference be found to the work on symmetry and crystal structure of Von Lang, Becke, Groth, or Muthmann. Gadolin is referred to, as he published in the French language, but the omission of British and Continental work to such an extent is a serious defect, as is also the fact that no references whatever to the literature of any original memoirs are vouchsafed.

Having accepted these limitations, however, and the further fact that practical details of crystallographic experimental work is not a feature of the book, an admirable summary of the work of Häüy, Lévy, Fresnel, Mallard, Bravais, Curie, Friedel, Bertrand, Séarmont, and other French men of science, will be found. Moreover, when the author is

on his own ground of pure physics, and especially in the discussion of such parts of his subject as are not affected by recent foreign work, his matter is excellent, vigorously and interestingly expressed, incisive and clear. One of the most valuable parts of the book is the chapter on space-lattices, which includes a capital account of the immensely important, even fundamental, work of Bravais, work which only increases in value as the years roll on. It is followed by a good description of the theory of "groups of movements," which has resulted in our knowledge of the 230 types of homogeneous structures, based chiefly, however, on the treatise of Schönflies.

A considerable part of the book is also occupied with the physics of homogeneous deformations, although all mention of work on the thermal dilatation of crystals subsequent to that of Fizeau is omitted, and the treatment of elasticity and elastic deformations is purely theoretical and lacks any reference to recent experimental work.

When the author enters the domain of the crystallographer it is, unfortunately, to display a complete want of knowledge of the immense progress which has been made, largely by British workers, in experimental methods, in the preparation of crystals of a high degree of perfection for the purposes of investigation, and of the highly accurate measurements which have been made during the last twenty years on such perfect crystals. The important laws governing the relations between crystalline structure and chemical constitution, especially those relating to the effect of the interchange of the variable elements in isomorphous series, which has been the main outcome of this work, is entirely ignored. It is with great surprise that we read, referring to the use of even an ordinary goniometer provided with telescope and collimator:—

"Ce procédé de haute précision n'est presque jamais employé. C'est que les faces d'un cristal sont loin d'être des miroirs parfaits. Elles sont souvent de très petites dimensions. Elles présentent souvent des irrégularités, des stries. . . . Les faces sont souvent courbes. Enfin, c'est un fait remarquable, les angles des cristaux cristallographiquement les plus beaux ne sont les mêmes d'un échantillon à l'autre ou d'un angle à son homologue qu'avec une tolérance souvent énorme. Il faut entendre par là que, mesurant, avec toute la précision possible, le même dièdre sur une série d'échantillons, ou les dièdres homologues d'un échantillon, on trouve des résultats qui peuvent différer de plus de dix minutes. Pour toutes ces raisons, une précision extrême est illusoire; l'emploi du goniomètre ordinaire, toujours inutile, est dans bien des cas absolument impossible."

It is difficult to understand how anyone holding such opinions as to the value of exact work in crystallography should wish to write a text-book on the subject. It is not by disseminating such opinions that the study of crystallography can be advanced, and young students attracted to a richly repaying and almost unopened branch of scientific investigation. If the worker in crystallography is content to take the first crystal he alights upon as the best sample procurable, he will, of course, conclude as the author has done. But if he takes the trouble to obtain the most perfect

procurable crystals for his investigations, and, if they are artificial chemical preparations, if he has followed and makes use of the recent work on the preparation of perfect individual crystals, and the precautions to be taken to avoid disturbance during growth, there will be a very different story to tell, and the deformations, striations, curvings, and lack of constancy of ten minutes or more will all disappear, and the angles will inform him, if he employs the most accurate goniometer in the market, of their constancy to the last minute. To speak, moreover, of "petites dimensions" as being a drawback is even more enlightening as to the author's lack of familiarity with practical crystallography. For it is precisely small crystals, varying from a very small pea to a pin's head in size, that the crystallographer chooses by preference for his measurements. For the liability to distortion is then at its minimum.

Sufficient will have been said to indicate the excellences and the defects of this volume, both striking in their way. Indeed, in spite of the aggravating defects which it has been essential to point out, the writer possesses so original and lively a style, and his remarks are often so well worth reading, that with all its shortcomings, the book has good and valuable qualities, and in the portions where the author is on his own domain is both well written and instructive.

A. E. H. TUTTON.

#### THE ORIGIN OF THE DIAMOND.

*Diamonds.* By Sir William Crookes, F.R.S. Pp. xvi + 146. (London and New York: Harper and Brothers, 1909.) Price 2s. 6d. net.

ALL who have had the pleasure of hearing Sir William Crookes's lectures on the diamond and its origin will be glad to find the valuable information contained in them put into a permanent form in the little book before us.

The author has had exceptional opportunities for studying the subject. During two visits to South Africa, in 1896 and 1905, he was allowed by the managers of the De Beers mines to have unrestricted access to valuable sources of information; and, as is so well known, his own physical and chemical researches have been largely concerned with questions connected with the properties and origin of the most remarkable, as well as the most highly prized, of the gems.

Concerning the Kimberley diamond mines, as well as the alluvial deposits of South Africa, Sir William Crookes can write with authority from his personal observations. As illustrating "the kind of speculative gambling" which goes on in the former class of workings, we are told of a claim where the owner had not seen a diamond for a fortnight, but just before then he had picked out a diamond worth 300!. On the other hand, the systematic work at the mines of the De Beers Company enables the management to regulate the annual supply with the greatest nicety, so as not to cause any fall in the price of the gem. In 1907 more than two and a half million carats were raised, which realised 6,452,597. The mode of occurrence of the diamonds, the methods of working

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adopted at different times in the wonderful pipes that yield the gems, and the ingenious methods of treating the "blue ground" and sorting out the stones, are described and illustrated by photographs taken by the author himself.

Sir William Crookes had the opportunity of handling and taking a photograph of the celebrated "Cullinan diamond" before it was cut, and his description of it is of much interest. He tells us that :

"A beam of polarised light passed in any direction through the stone, and then through an analyser, revealed colours in all cases, appearing brightest when the light passed along the greatest diameter—about 4 inches. Here the colours were very fine, but no regular figure was to be seen. Round a small black spot in the interior of the stone the colours were very vivid, changing and rotating round the spot as the analyser was turned. These observations indicated internal strain. The clearness throughout was remarkable, the stone being absolutely liquid like water, with the exception of a few flaws, dark graphitic spots, and coloured patches close to the outside. At one part near the surface there was an internal crack, showing well the colours of thin plates. At another point there was a milky, opaque mass, of a brown colour, with pieces of what looked like iron oxide. There were four cleavage planes of great smoothness and regularity. On other parts of the surface the crystalline structure was very marked. The edges were rounded in parts, and triangular markings (depressions) were to be seen. I also noticed square depressions, nearly as sharp and perfect as the triangular ones."

Interesting as this description undoubtedly is, we cannot but regret that, before this unique specimen was deprived of its interest for mineralogists by being cut, no opportunity was afforded to the author, or any other scientific investigator, of carrying out such a series of observations in the laboratory as would have enabled him to place on record all the facts about it which it was desirable to obtain.

A full account of the Cañon Diablo meteorite, with its enclosed diamonds, and of the vast crater-like depression in Arizona where it was found, is given in the concluding chapter. The author, in discussing the genesis of diamonds, is clearly of opinion that, whether of inter-terrestrial or of extra-terrestrial origin, the conclusion is established, both by observation and experiment, that the solvent from which the carbon has crystallised must have been molten iron.

In conclusion, we cannot but commend, to all desirous of learning what is known about the most beautiful and interesting of gems, this terse and attractive—but withal trustworthy and complete—summary of all the information on the subject which has up to the present been acquired. J. W. J.

#### DIFFERENTIAL GEOMETRY.

*A Treatise on the Differential Geometry of Curves and Surfaces.* By Prof. L. P. Eisenhart. Pp. xii + 474. (London and Boston: Ginn and Co., n.d.) Price 2os.

THE well-known works of Darboux and Bianchi are so excellent, each in its own way, that one might be inclined to doubt whether another text-book on the subject was really required—at least, for the